

GPM Ground Validation High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) IPHEX

Introduction

The GPM Ground Validation High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) IPHEX dataset was collected during the Global Precipitation Measurement (GPM) Ground Validation Integrated Precipitation and Hydrology Experiment (IPHEX) field campaign in North Carolina. The goal of IPHEX was to evaluate the accuracy of satellite precipitation measurements and use the collected data for hydrology models in the region. The NASA ER-2 aircraft flew during the IPHEX field campaign to aid in GPM validation. The science instruments, including the HIWRAP, onboard the aircraft acted as a proxy for GPM satellite instruments. HIWRAP is a Doppler radar that combines conical scan mode measurements at two different frequency bands (Ka- and Ku-band) and two different incidence angles (30 and 40 degrees). Twenty-one ER-2 flights occurred from May 1, 2014 through June 14, 2014. The HIWRAP dataset includes netCDF-4 and HDF-5 files containing radar reflectivity and Doppler velocity profiles along with aircraft altitude and other navigation information.

Notice: Since flights did not occur on a regular basis during the field campaign, there are missing days between May 3, 2014 through June 12, 2014.

Citation

Heymsfield, Gerald M and Lin Tian. 2016. GPM Ground Validation High Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) IPHEX [indicate subset used]. Dataset available online from the NASA Global Hydrology Resource Center DAAC, Huntsville, Alabama, U.S.A. DOI: <http://dx.doi.org/10.5067/GPMGV/IPHEX/HIWRAP/DATA101>

Keywords

NASA, GHRC, PMM, GPM, IPHEX, HIWRAP, North Carolina, aircraft observations, ER-2, Doppler Velocity, Radar Reflectivity

Campaign

The Global Precipitation Measurement mission Ground Validation (GPM GV) campaign used a variety of methods for validation of GPM satellite constellation measurements prior to and after the launch of the GPM Core Satellite, which launched on February 27, 2014. The instrument validation effort included numerous GPM-specific and joint agency/international external field campaigns, using state of the art cloud and precipitation observational infrastructure (polarimetric radars, profilers, rain gauges, and disdrometers). These field campaigns accounted for the majority of the effort and resources expended by the GPM GV mission. More information about the GPM GV mission is available at the [PMM Ground Validation webpage](#).

One of the GPM Ground Validation field campaigns was the Integrated Precipitation and Hydrology Experiment (IPHEX) which was held in North Carolina during 2014 with an intense study period from May 1 to June 15, 2014. The goal of IPHEX was to characterize warm season orographic precipitation regimes and the relationship between precipitation regimes and hydrologic processes in regions of complex terrain. The IPHEX campaign was part of the development, evaluation, and improvement of remote-sensing precipitation algorithms in support of the GPM mission through the NASA GPM GV field campaign (IPHEX_GVFC) and the evaluation of Quantitative Precipitation Estimation (QPE) products for hydrologic forecasting and water resource applications in the Upper Tennessee, Catawba-Santee, Yadkin-Pee Dee, and Savannah river basins (IPHEX-HAP, H4SE). NOAA Hydrometeorology Testbed (HTM) has synergy with this project. More information about IPHEX is available at the [IPHEX Field Campaign webpage](#).

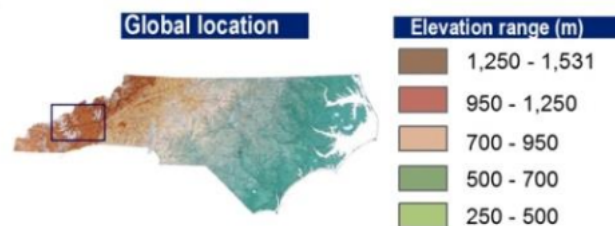


Figure 1: Region of North Carolina IPHEX campaign ground validation
(image source: <http://gpm-gv.gsfc.nasa.gov/Gauge/>)

Instrument Description

The High Altitude Wind and Rain Airborne Profiler (HIWRAP) is a Doppler radar designed to measure tropospheric winds through the derivation of Doppler profiles from cloud and precipitation volume backscatter ([Li et al., 2016](#)). The wind measurements are generated by combining conical scan mode measurements at two different frequency bands (Ka- and Ku-band) and two different incidence angles (30 and 40 degrees). HIWRAP utilizes solid-state transmitters along with a novel pulse compression scheme resulting in a system that is considerably more compact and requires less power than typical radars used for precipitation and wind measurements. A more detailed description of the HIWRAP system, system parameters, and data processing can be found in [Li et al., 2016](#). More information about HIWRAP can also be found on the [Goddard Space Flight Center High Altitude Radar webpage](#).

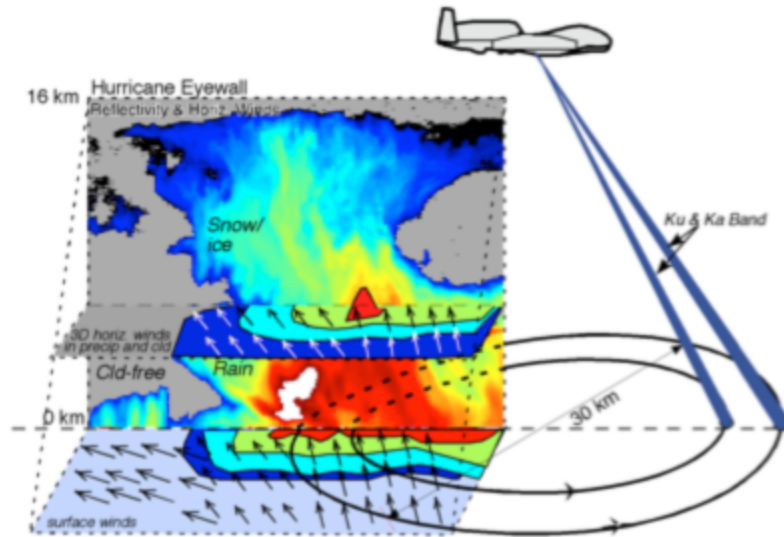


Figure 3: Image of the measurement concept of HIWRAP
(Image source: [GSFC HIWRAP webpage](#))

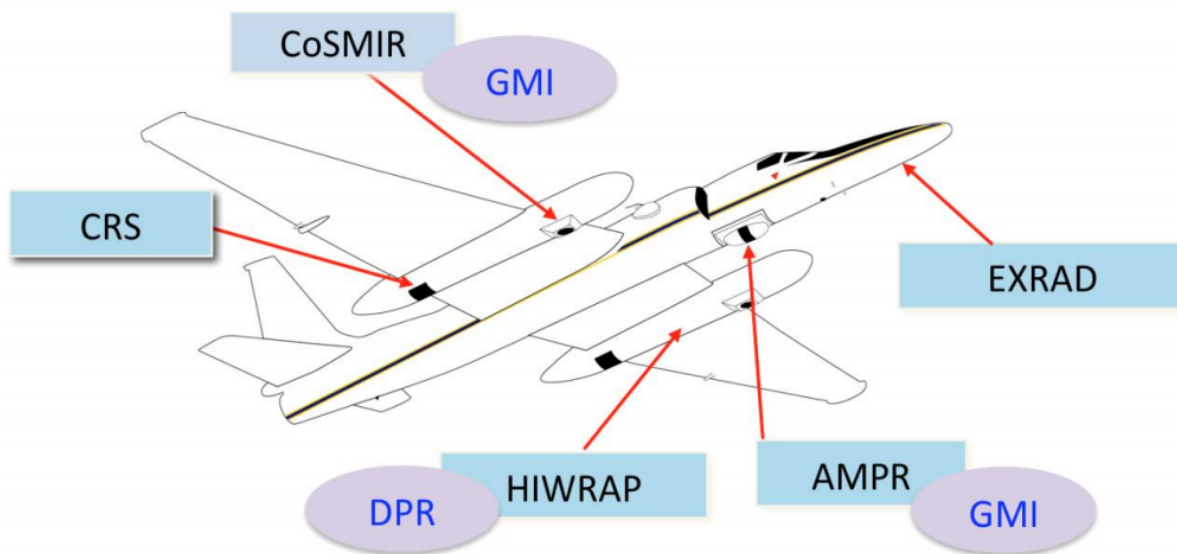


Figure 4: Location of IPHEX remote sensing instruments on the NASA ER-2 aircraft. The blue boxes label the instruments onboard, and the purple circles indicate which GPM Satellite instrument they can simulate.
(Image source: [IPHEX Science Plan](#))

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Data Characteristics

The GPM Ground Validation High Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) IPHEX data are available in netCDF-4 and HDF-5 formats. These Level 1B data files contain calibrated reflectivity and Doppler velocity profiles along with aircraft altitude and other navigation information. The files are generally split into one-hour intervals with a small amount of overlap before and after the hour mark. More information about the NASA data processing levels is available on the [EOSDIS Data Processing Levels](#) webpage.

Table 1: Data Characteristics

Characteristic	Description
Platform	NASA Earth Resources-2 (ER-2)

Instrument	High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP)
Spatial Coverage	N:36.643, S:26.799, E:-71.938, W:-86.562 (North Carolina)
Spatial Resolution	Vertical: 150 m Horizontal: 0.6 km
Temporal Coverage	May 3, 2014 - June 12, 2014
Temporal Resolution	Hourly -< Daily
Parameter	Radar Reflectivity, Doppler Velocity
Version	1
Processing Level	1B

File Naming Convention

The IPHEX High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) dataset files are named with the following convention:

Data files: IPHEX_HIWRAP_LIB_<start time>_<end time>_H[Ka|Ku]_dist_v01.[nc|h5]

Table 2: File naming convention variables

Variable	Description
<start_time>_<end_time>	Start and end time of the flight as YYYYMMDD-hhmm, where: YYYY = four-digit year MM = two-digit month DD = two-digit day hh = two-digit hour, in UTC mm = two-digit minute, in UTC
H[Ka Ku]	Ka: Ka frequency band Ku: Ku frequency band
.[nc h5]	nc: netCDF-4 file type h5: HDF-5 file type

Data Format and Parameters

The GPM Ground Validation High Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) IPHEX dataset files consist of radar reflectivity, Doppler velocity, and aircraft navigation information. Table 3 gives the description, data type, and units for each parameter provided in the data files.

Table 3: Data Fields

Field Name	Description	Data Type	Unit
altitude	Aircraft Altitude	float	m

dopcorr	[Ka Ku] Doppler velocity after correct for aircraft motion and folding	float	m/s
evel	East aircraft ground speed	float	m/s
gatesp	Radar range gate	float	m
gspeed	Aircraft ground speed	float	m/s
head	Aircraft heading	float	degrees
lat	GPS aircraft latitude, minus sign = South	float	degrees north
lon	GPS aircraft longitude, minus sign = West	float	degrees east
missing	Missing value	float	-
noise_thresh	Noise threshold	float	-
nvel	North aircraft ground speed	float	m/s
pitch	Aircraft pitch angle	float	degrees
range	Range from radar	float	m
roll	Aircraft roll angle	float	degrees
sigm0	Surface sigma0	float	dB
tilt	Incidence Angle	float	degrees
timed	UTC time	float	-
track	Aircraft track angle	float	degrees
vacft	Estimate of aircraft Doppler component	float	m/s
wlku	Wavelength length of radar	float	m
wvel	Aircraft vertical speed	float	m/s
year	Year the data was collected	float	-
zku	[Ka Ku] Radar Reflectivity	float	dBZ

Algorithm

The HIWRAP instrument uses Doppler radar backscatter from clouds and precipitation to derive tropospheric winds. Measuring backscatter at two different frequencies and incidence angles allows for 3D winds to be derived. Additional information on how the HIWRAP instrument obtains its measurements is detailed in [Li et al., 2016](#).

Quality Assessment

The HIWRAP instrument is calibrated in three steps: using parameters of individual components to calibrate the system, using the return of the ocean surface as an external reference, and calibrating the system internally using a pulse-by-pulse calibration while processing post-flight data. To maintain high temporal and spatial resolutions, the transceiver supports simultaneous operation at the two center frequencies for each band so that they align with one of the two incident angles. More information is available in [Li et al., 2016](#). Also, HIWRAP Ku-band linear depolarization ratio data often experienced radio frequency interference from the ground-based D3R radar.

Software

This dataset is in netCDF-4 and HDF-5 formats and does not require any specific software to read. However, the data is easily readable and viewed in [Panoply](#).

Known Issues or Missing Data

Since flights did not occur on a regular basis during the field campaign, there are missing days between May 3, 2014 through June 12, 2014. Also, no wind information is available in these dataset files. Wind measurements are derived from the calibrated doppler velocities and released in a higher level product. Within each data file, there is a variable named 'missing', which indicates missing values within the data.

References

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Related Data

All datasets from the IPHEX field campaign are considered related to this dataset. They can be located using the GHRC [Hydro2.0](#) search tool and searching the term 'IPHEX'. The

HIWRAP instrument was also deployed in other field campaigns. The HIWRAP data from other campaigns can be located by searching 'HIWRAP' in [Hydro2.0](#) and are listed below.

GPM Ground Validation High Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP)
OLYMPEX

(<http://dx.doi.org/10.5067/GPMGV/OLYMPEX/HIWRAP/DATA101>)

GPM Ground Validation High Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP)
MC3E

(<http://dx.doi.org/10.5067/GPMGV/MC3E/HIWRAP/DATA101>)

GRIP High Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP)

(<http://dx.doi.org/10.5067/GRIP/HIWRAP/DATA101>)

Contact Information

To order these data or for further information, please contact:

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Huntsville, AL 35805

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